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EXPERIENCE IN EQUIPMENT AND
BUILDING DECONTAMINATION IN THE
MANUFACTURE OF R-140

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Problem Assignment TXI-1

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EXPERIENCE IN EQUIPMENT AND
BUILDING DECONTAMINATION IN THE
MANUFACTURE OF Ba¹⁴⁰

Introduction

Contamination usually exists as compounds of the various fission products which may either adhere to the surface of the contaminated material or be absorbed into the material if it is porous. Decontamination involves the removal of these compounds by dissolution or by mechanical methods.

Since the composition of the contaminating material may vary and is not usually known, it is impossible to set forth ironclad rules governing the best methods and reagents to be used in decontamination. This discussion is, therefore, offered only as guide, based on experiences in this particular process.

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General

Decontamination, at its best, is a time consuming and expensive job. Every possible effort should be made to prevent its need. One of the most practical methods found to do this is to cover exposed areas and equipment with heavy absorbent paper which can be thrown away when it becomes contaminated.

The methods and reagents used in decontamination vary with the size, location, and material of construction of the affected parts. Small objects which are not damaged by long contact with liquids are usually decontaminated easily by immersing them in an appropriate reagent. This method is by far the easiest and the safest from the standpoint of personnel exposure.

The greatest problems occur in the decontamination of the building, equipment that is too bulky to handle in the manner described in the preceding paragraph, and the inside of the cells where most of the work must be done by remote control.

Building and Large Equipment

Some of the decontamination agents most commonly used are nitric acid, hydrochloric acid, a solution of ammonium silicofluoride in weak nitric acid, citric acid, sodium citrate, a solution of sodium carbonate, water, steam, and soap.

The strong acids and the ammonium silicofluoride solutions are usually most effective on non-porous surfaces. These reagents, however, must be used with discretion since they may attack the surface of the material being cleaned to such an extent as to decrease its usefulness. On the other hand, the removal of a thin layer from the surface may prove to be desirable when the value of the material would not be affected and the contamination is found to be extremely difficult to remove. Metal surfaces which may be covered with a film of oil can be very effectively decontaminated by swabbing with a cloth soaked in acetone followed by a rinse in hydrochloric acid.

Porous materials such as concrete or wood are extremely difficult to decontaminate since solutions which are applied are usually absorbed, along with some of the contamination, into the material. All building material of this type should be painted when new, preferably with acid proof paint, to facilitate decontamination when need arises. The use of strong acids on concrete should be discouraged. Although the bulk of the contamination may be

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removed by one treatment of strong acid, the surface is roughened to such an extent that some portion of the contamination invariably penetrates deeply into the concrete. Further decontamination can then only be accomplished by removing the contaminated surface with an air hammer. The weak reagents, such as soap and soda ash, are by far the most satisfactory in the long run even though the initial removal of the contamination may appear negligible in comparison to that of strong acids.

Steam has been proved to be one of the most efficient of all decontaminating agents in a great many cases. Its value cannot be overemphasized in decontaminating closed vessels and pipe lines where it is difficult to bring all of the contaminated surfaces and crevices in contact with other reagents. This operation usually contaminates the air so that it must be carried out on the outside of the building or in a place ventilated in such a manner as to prevent the contamination of air in the operating area.

Cell Decontamination

The inside dimensions of the two main cells in this building, Cells "A" and "B", are 10' x 20' x 25' and 10' x 15' x 15' respectively. The walls are of concrete covered with Uclon paint to prevent absorption of activity. The floors and sumps are covered with sheet lead.

Cell A contains six stainless steel process tanks ranging in capacity from 115 to 850 gallons. Three of these vessels stand on concrete pads on the cell floor and the other three are suspended on black iron beams which are covered with Uclon paint to prevent corrosion during cell decontamination. There are two off-gas lines and two scrubbers in this cell. These off-gas lines keep all vessels in both cells under vacuum at all times to prevent radioactive gases from escaping into the building atmosphere.

Cell B contains 14 vessels. Five of these are the main stainless steel process vessels which vary in capacity from 44 to 80 liters. The other nine vessels include three 2.7 liters stainless steel stationary pipettes, two 8 liters movable pipettes, one 5 liter Hastelloy "C" transfer vessel, two 6.5 liter stainless steel transfer vessels and one 2.8 liter Hastelloy C sampling vessel. All equipment in this cell is mounted on painted black iron beams.

To bring down the radiation levels to a point low enough to permit safe entrance to a cell, it is necessary to decontaminate practically every surface in the cell. This includes the inside and outside of the vessels, the off-gas lines, transfer lines, walls, beams, and floor. The length of time and manpower required to complete the decontamination of a cell varies with the amount and nature of the work required in the cell. In the past,

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one to three weeks of continuous decontamination with three men to a shift was adequate to give a working time varying from 30 seconds to several hours depending on the location in the cell. Working times are based on an exposure of 50 mr per day for cell jobs because of the existence of so many "beams" of activity higher than general background.

Vessel and Transfer Line Decontamination

The insides of all vessels, transfer lines, and funnels are first rinsed with water several times to remove the bulk of the loose contamination. These rinses are then followed by several cycles of nitric acid which are in turn followed by cycles of soda ash solution.

The nitric acid cycle consists of adding the nitric to one of the vessels, boiling (by heating with jacket steam) for approximately 30 minutes, cooling to jetting temperature, jetting a small portion through each of the transfer lines leading out of the vessel, and jetting it to another vessel where the process is repeated. When the cycle is completed through every vessel, the acid is stored in the neutralizing tank.

The soda ash solution cycles are handled in the same manner and the waste solution is jetted into the nitric acid. This neutralizes the acid so that the combined waste can then be transferred to the tank farm.

The strength of the acid used varies from 5% to 60%. No general optimum strength has been determined. Strong nitric is not usually used in the decontamination of the large tanks in Cell A, since the large capacities would require handling of extremely large quantities of the strong acid. The soda ash is used in a 15% solution.

The cycles of 5% ammonium silicofluoride plus 10% nitric acid which follow the soda ash cycles are carried out in similar manner but the solution is not heated at any time. This is to prevent excessive corrosion of the vessels by the solution. Instead of heating, the solution is agitated by mechanical agitators or air spargers for $\frac{1}{2}$ hour periods. These cycles are again followed by soda ash as previously described, the waste is neutralized and disposed of.

A total of 10 to 15 cycles of nitric acid and ammonium silicofluoride is usually sufficient to remove practically all contamination from the exposed surfaces on the interior of vessels. These treatments, however, do not thoroughly remove the contamination lodged in the crevices and flanges on the tops of the vessels so that other methods must be employed. The most effective method found thus far has been thorough steaming of the vessels. This procedure is described below.

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Decontamination of Movable Pipettes

The contamination in these vessels is removed by repeated washings using nitric acid and 5% nitric plus 10% ammonium silicofluoride. The pipette is filled to approximately two-thirds capacity and with the vacuum on, the solution is sparged for 15 minute periods. A total of 10 to 15 washes is usually sufficient to remove most of the contamination.

Steaming of these pipettes has been found impractical because the two openings to these vessels are very small and the small amount of steam sent to the pipettes is condensed in the lines before it gets to the pipettes and drains out of the vessel without filling it.

Decontamination of Stationary Pipettes

These pipettes can be completely decontaminated by steam. The steam is introduced into the pipette through the pressure-vacuum line at the control panel board. This process is continued for about 16 hours.

Hosing and Steaming of Cells

While the decontamination of the vessels is in progress, frequent readings of the radiation at the cell entrance are taken. As soon as the radiation level at the entrance permits several seconds working time, a fire hose is set up on an iron stand and all the equipment and walls of the cell are thoroughly hosed down to a point where further hosing fails to appreciably bring down the radiation level. This usually takes one day and the radiation at the cell entrance when the hosing is completed is usually low enough to permit several minutes working time at that point.

Although steaming of the cell can remove contamination where almost every other method may fail, it should be carried out only after the bulk of contamination is removed by methods previously described. Failure to do this may result in high building air contamination.

Before turning on the steam, all the walls and equipment are wetted with a hose and a heavy layer of soda ash is thrown over all the equipment, beams, floor, and walls with a sandblaster. The cell ventilation and vessel off-gas lines are turned off. With the vessels empty, all steam jets in the cell are turned on. The steam escapes through the tops of the tanks and condenses on all surfaces in the cell, dissolves the soda ash and bathes all these surfaces with a hot soda ash solution. To decontaminate the off-gas line and scrubber, steam is introduced into the scrubber through the solution addition line at the control board. The steaming is continued for 3 or 4 hours after which the cell is thoroughly hosed down.

This process is repeated, using soda ash or citric acid until it becomes ineffective.

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When the radiation levels in the cell permit entrance far inside the cell, steam lines are inserted into the open sampling vessel and open funnels and steam is blown into these for several hours until its effectiveness is negligible.

Acid Spray

In general, the methods described above are sufficient to decontaminate the cells to levels low enough to permit some maintenance work. If these methods fail to result in adequate working time, it may be necessary to spray weak nitric acid or weak hydrochloric acid over the local "hot spots" in the cell where the work must be done. These sprays are followed by thorough hosing down with water.

Spraying acid over the cell, although sometimes necessary, usually results in some damage to beams, floors and other equipment made of materials other than stainless steel.

Water Soluble Paints

The covering of walls and equipment with a water soluble paint to facilitate removal of contamination inside the cell was found impractical in this particular process. This was due to the fact that steam escaping from the process lines into the cell caused the paint to soften and drip off the ceiling into the process vessels.

Exposure Control

During the first several decontaminations of the cells, all working time in the cells were based on 100 mr exposure (plant tolerance) and no limit was placed on the intensity of radiation to which a person was exposed. Due to the normal inaccuracies in the surveys made, the great variation in radiation intensities in the cells, and sometimes the very high radiation levels, many overexposure reports from the Health Physics Department were received. To minimize the possibility of more overexposures, the following building rules have been set up and followed with success:

- (1) No part of the body is to be exposed to radiation greater than 6 R/hr.
- (2) All working time calculations are to be based on an exposure of 50 mr.

Calculation of working time based on "dosemeter" readings was found impractical due to the inaccuracy of the instruments and the inconvenience in wearing them.